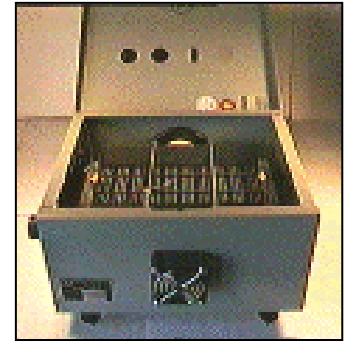
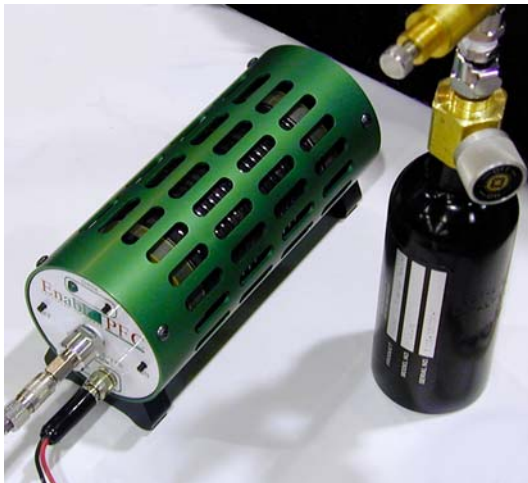
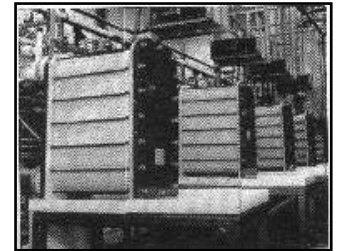




Fuel Cells for Buildings Roadmap Workshop

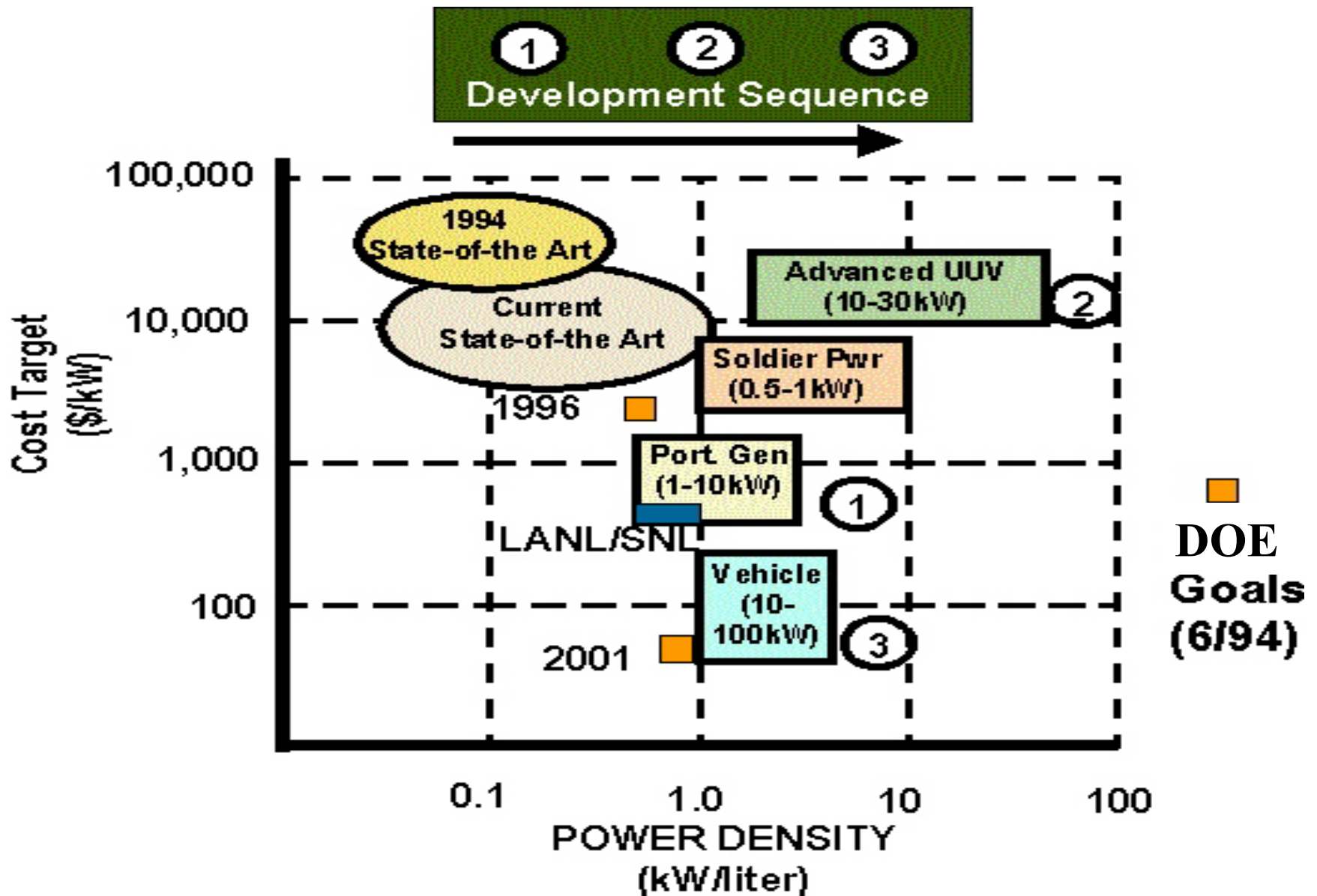


Hydrogen Briefing Neil Rossmeissl April 11, 2002



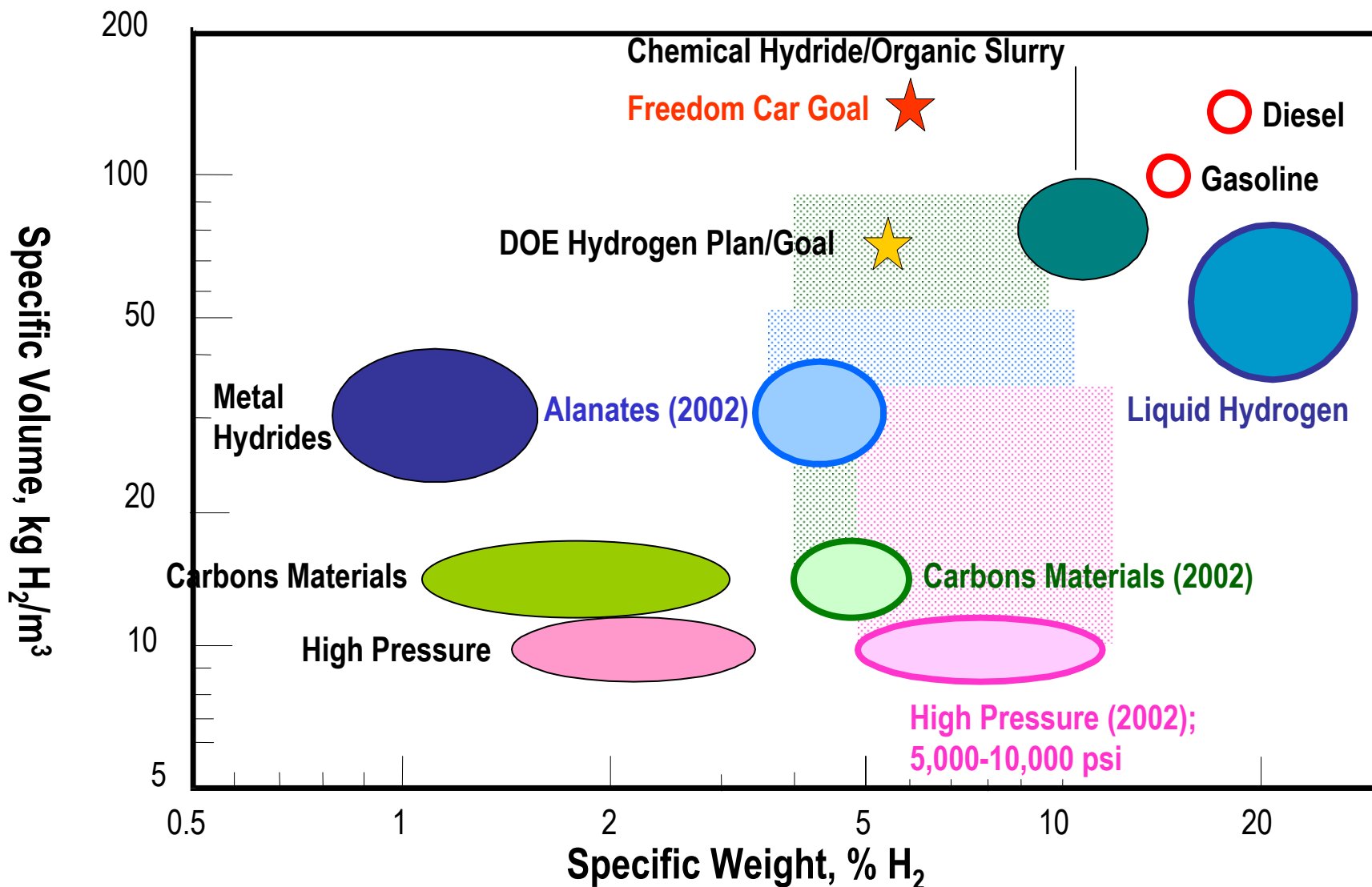
PEM FUEL CELL REQUIREMENTS

From June 1994



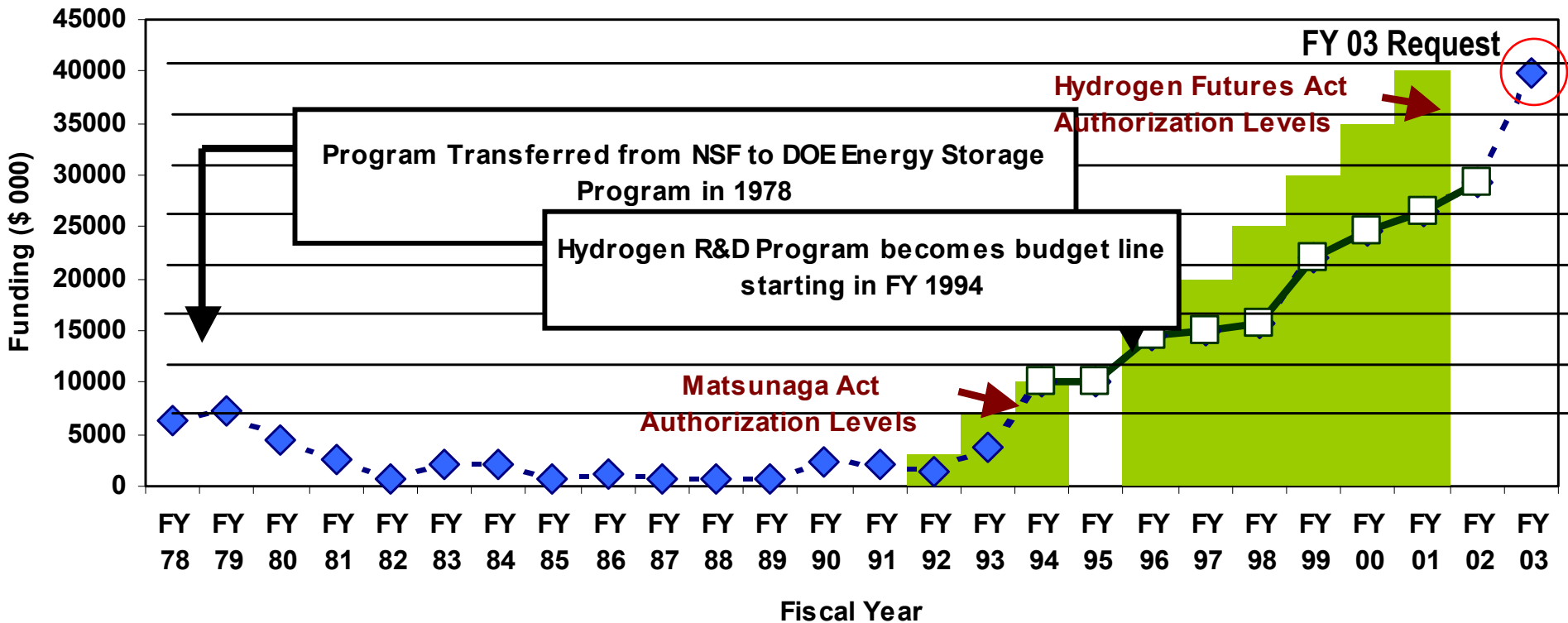
Hydrogen Storage Developments

Reference Data From the R&D Roadmap 1998



Hydrogen Program Funding Summary

Hydrogen R&D Program -- Historical Funding



Legislative Mandates

Pursuant to Matsunaga Hydrogen RD&D Act and the Hydrogen Futures Act of 1996, 2002:

Title 1 Hydrogen

“...to direct the Secretary of Energy to conduct a research, development, and demonstration program leading to the production storage, transport, and use of hydrogen for industrial, residential, transportation, and utility applications”

- **Allows demonstrations with at least 50% non-Federal cost-share**
- **Accelerates “critical” R&D**
- **Calls for fostering technology transfer**
- **Authorizes a total of \$290 million in spending;**
- **Reauthorize the formation of the Hydrogen Technical Advisory Panel to review the program activities and make recommends to the Secretary on implementation and conduct of the program.**

FY 1996-2001

Reauthorization Approved in House, Senate has not acted

Legislative Mandates

Pursuant to Matsunaga Hydrogen RD&D Act and the Hydrogen Futures Act of 1996, 2002:

Title 2 Fuel Cells (amended for 2002)

“...to direct the Secretary of Energy to solicit proposals for projects to prove the feasibility of integrating fuel cells into Federal, State, and local government facilities for stationary and transportation applications.”

- **Allows demonstrations with at least 50% non-Federal cost-share**
- **Accelerates “critical” R&D**
- **Calls for fostering technology transfer**
- **Authorizes a total of \$130 million in spending;**
- **Not later than 120 days after the date of enactment of this section, the Secretary shall establish an interagency task force led by a Deputy Assistant Secretary of the Department of Energy and comprised of representatives, OSTP, DOT, EPA, NASA, DOD, DOC.**
- **Original authorization 1996 - 2001**
- **Reauthorization approved in House, Senate has not acted FY 2002- 2006**

Legislative Mandates

Technical Panel

Comprised of representatives from industry, universities, professional societies, Government Labs, financial, environmental, and other appropriate organizations.

Proposed New Members:

| | | |
|------------------------|--------------------------------------|-----------------|
| Mr. John O'Sullivan | EPRI (retired) | Reappointed |
| Dr. Chung Liu | SCAQMD | Reappointed |
| Ms. Carol Bailey | ChevronTexaco | Reappointed |
| Mr. Jason Mark | Union of Concerned Scientists | Reappointed |
| Dr. Roberta Nichols | Ford Motor Company(retired) | Reappointed |
| Mr. David Haberman | DCH Technologies | Reappointed |
| Dr. George Schmauch | Air Products and Chemicals (retired) | Reappointed |
| Dr. Helena Chum | National Renewable Energy Laboratory | Reappointed |
| Dr. Vernon Roan | University of Florida | New appointment |
| Mr. Karl Rábago | Rocky Mountain Institute | New appointment |
| Dr. J. Byron McCormick | General Motors | New appointment |
| Dr. Douglas Wheeler | UTC Fuel Cells | New appointment |
| Dr. Jan Hamrin | Center for Resource Solutions | New appointment |
| Dr. Robert Miller | Air Products and Chemicals | New appointment |



Program Participants



122 West



DCH
TECHNOLOGY

JOHNS HOPKINS
UNIVERSITY



MIT

UNIVERSITY OF
Miami

TECOGEN
Natural Gas Engine-Driven Products



National Power

TELEDYNE
BROWN ENGINEERING
A Teledyne Technologies Company



Natural Resources
Canada



PRAXAIR



AIR
PRODUCTS



NRG Technologies, Inc.



A WORLD OF ENERGY.



Technology Management, Inc.

Princeton University



We bring good things to life.



Integration With Other Programs



California Fuel Cell Partnership

- Provide Hydrogen Infrastructure
- Provide Pressurized Storage Tanks



Southcoast Air Quality Management District

- Provide Hydrogen Infrastructure

Codes and Standards

- International Code Council
- National Fire Protection Association

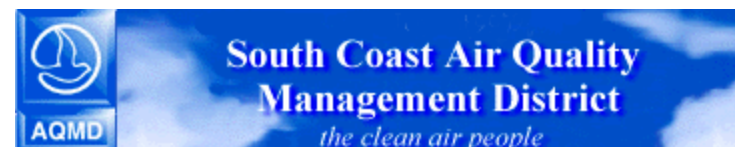


Department of Transportation

NASA

GTI

- Fuel-maker for Hydrogen Infrastructure Working Group



Assistant Secretary Garman's

9 Priorities

EERE's Priorities: Hydrogen

1. Dramatically reduce or even end dependence on foreign oil
3. Increase viability and deployment of renewable energy.
4. Increase reliability and efficiency of electricity generation.
9. Lead by example through government's own actions.

Milestones and Deliverables

Install distributed refueling stations that can produce hydrogen untaxed at \$1.25 per gallon equivalent.

Hydrogen storage system that can provide 6% by weight hydrogen and 250 – 400 miles of range.

Validate integrated systems into Power Parks that co-produce electricity (<\$0.06/kW) and hydrogen.

Priority/Support

1. Balanced research, development and validation program to produce hydrogen from indigenous fossil and non-fossil sources.
3. Initiated a number of collaborations with Wind, CSP and DER programs using energy storage.
4. Collaborated with other EERE and FE programs on integrating fuel cells with hydrogen production
9. Last three years have developed collaborations with FE,OIT,OTT, DOT to foster major hydrogen initiatives.

Major Accomplishments

Awarded three cooperative agreements with industry teams for hydrogen refueling stations.

Completed certification of a 6% by weight, 5000 psi cyrogas hydrogen storage tank.

Completed 100 cycles of a 5.2 % by weight hydride tank.

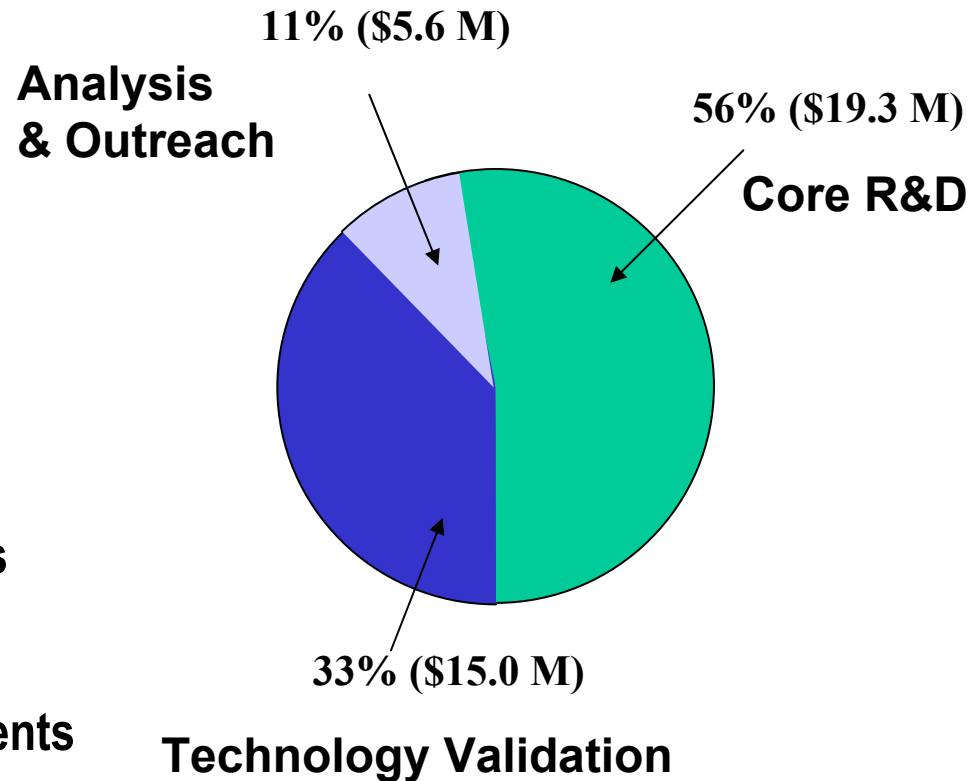
Completed testing of hydrogen production and 50kWe hydrogen fuel cell.



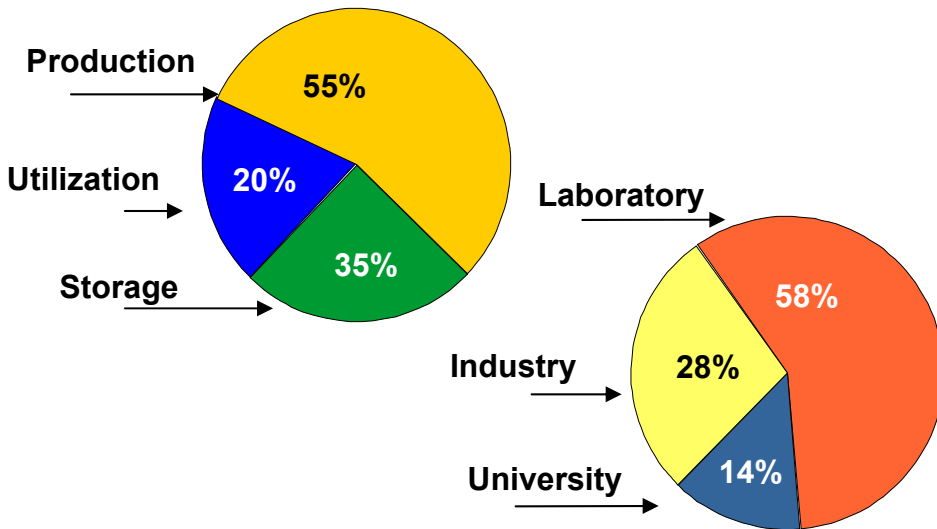
Hydrogen Program Structure



- **Core R&D**
 - Production
 - Storage
 - Utilization
- **Technology Validation**
 - Renewable Hydrogen Systems
 - Hydrogen Infrastructure
 - Distributed/Remote Power Systems
- **Analysis and Outreach**
 - Economic and Technical Assessments
 - Operational Database on Validation
 - Projects for Codes & Standards



Core R&D Thrust FY02



Storage: \$ 7.84 M

FY 01 Milestones

Developed new method to synthesize catalyzed alanate.

Demonstrated thermal compressor at 6000 psig.

FY 02 Milestones

Validate 5.2% by weight storage on catalyzed alanate with over 1000 cycles.

Scale up thermal compressor to 15 liters/min

Production : \$ 7.76 M

FY 01 Milestones

Completed construction of ITM PDU

Operated a 5 liter bioshift reactor on a slipstream of syngas.

FY02 Milestones

Operate PDU continuously at 24,000 SCFD of syngas to verify performance.

Operate the 5 liter bioshift reactor at 10 psi on a slipstream of syngas

Utilization : \$ 3.74 M

FY 01 Milestones

Supported CaFCP by modeling maintenance building ventilation.

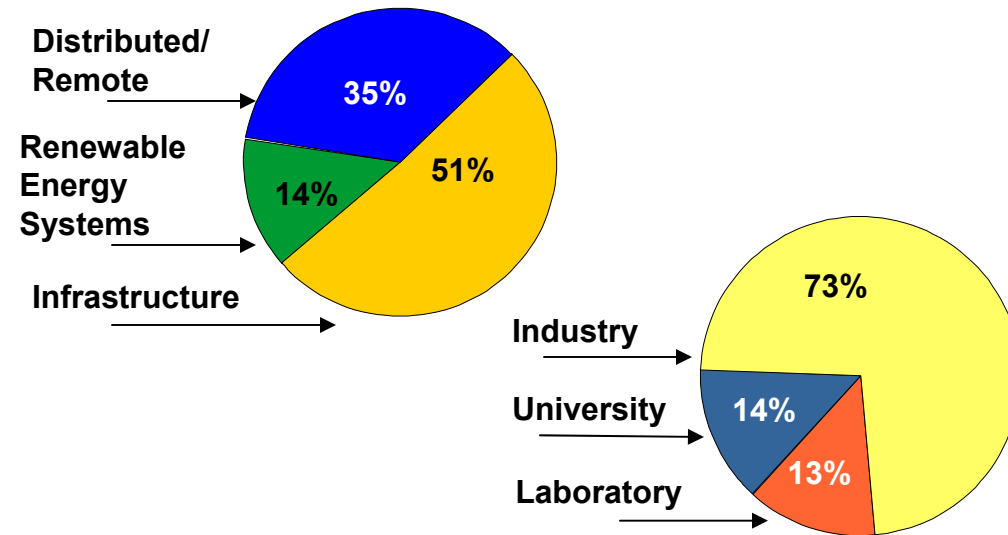
Hydrogen additions to natural gas extended the lean flammability limits cutting NO_x by 25%.

FY 02 Milestones

Demonstrate 200 W advanced PEM fuel cell for personal mobility devices.

Quantify the effect of adding up to 100% hydrogen to combustion turbine emissions.

Technology Validation Thrust FY02



Hydrogen Infrastructure (\$ 6.5M)

FY01 Results

Fabricated and test components for fueling station.
Validated 5000 psi composite tanks.

FY02 Milestones

Certify pressure vessels.
Demonstrate co-production refueling station with 50 kW hydrogen fuel cell.

Renewable Energy Systems (\$ 2.65 M)

FY01 Milestones

Reduced cost of hydrogen production from wind and biomass pyrolysis.

Completed electrolysis/metal hydride hydrogen scooter.

FY02 Milestones

Demonstrate utility energy storage system.
Optimize fluidized bed reformer for biomass pyrolysis
Complete electrolyzer cost reduction efforts

Distributed/Remote Power (\$ 5.85 M)

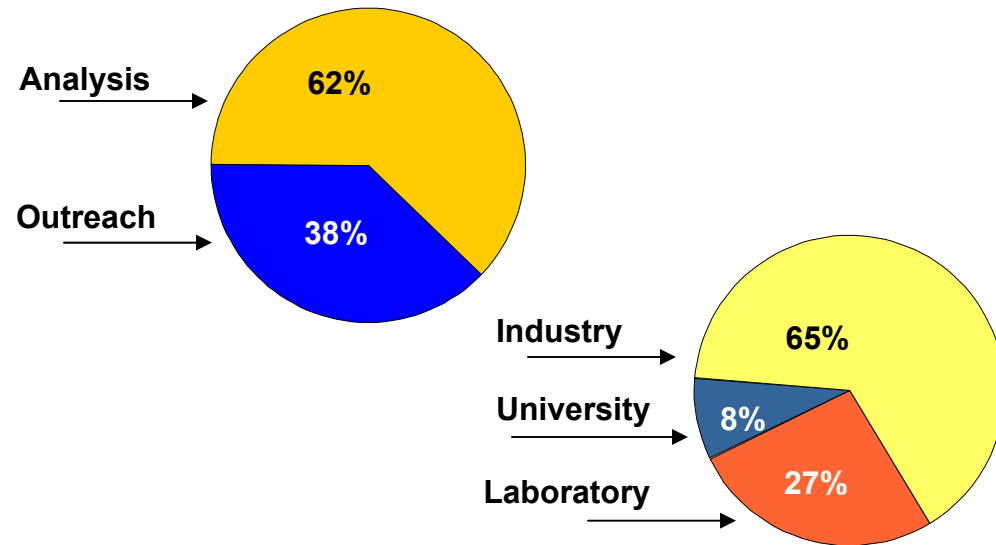
FY01 Milestones

Determined suitability of PEM fuel cells for stationary applications.
Completed power park scenario analysis and associated component costs and efficiencies.

FY02 Milestones

Complete design of power park
Demonstrate distributed remote FC

Analysis & Outreach Thrust FY02



Outreach: (\$ 2.11 M)

FY 01 Milestones

Completed hydrogen curriculum for high schools and colleges.

Complete educational module to support DER outreach program to educate state and local officials.

FY 02 Milestones

Complete a one-day educational program for NFPA on hydrogen.

Complete working script for hydrogen new age film.

Analysis: (\$ 3.44 M)

FY 01 Milestones

Developed with ICC 24 amendments to the building codes.

Completed flammability tests on sheetrock for garage modeling.

FY02 Milestones

Complete the assessment of natural gas reforming using solar energy.

Support industry participation at the ICC hearing to approval the hydrogen amendments.

Codes and Standards: (\$ 1.2 M)*

FY 02 Major Initiatives

Complete educational training seminar in collaboration with NFPA on hydrogen energy and fuel cells.

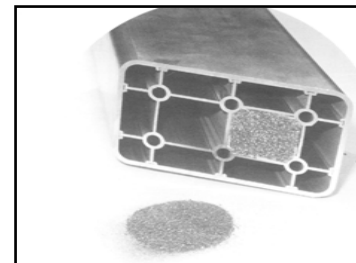
Complete amended code changes for the NFPA fuel gas and fuel cell codes.

Complete hydrogen version of NGV2 tank standards.

* Note: funding is part of analysis



Key Events for Next Year



- ☑ Operation of Hydrogen Fueling Station
- ☑ Demonstration of Light-weight Pressurized Storage Tanks
- ☑ Demonstration of Hydride Storage System
- ☑ Demonstration of .01 Gram Carbon Nanotube Material
- ☑ Demonstration of Reversible Fuel Cell

